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**FINAL REPORT**

**X-RAY ASTRONOMY INSTRUMENTATION STUDIES**

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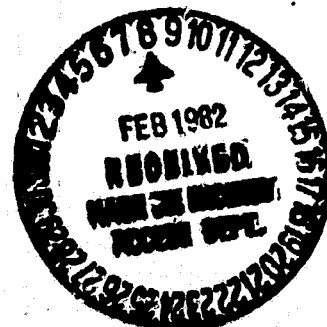
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## TECHNICAL REPORT

The technical report on the work done is divided into four sections below:

Proportional counter design

Laboratory measurements of fluorescent radiation

Design and construction of a counter gas filling system, and

Electronic engineering support.

### PROPORTIONAL COUNTER DESIGN

Preliminary designs were made for a multiplane multiwire position-sensitive proportional counter for x-ray use. Anode spacing was 2 mm and cathode spacing 1 mm. Gap width was 1.6 mm (nominal). Layouts for the electrode support planes were drawn and photographed and some printed-circuit test samples were manufactured from high quality fiberglass-epoxy board. An assembly jig and precision wire mounting frame were also made. Previous experience indicates that wires can be positioned by this means within a few tenths of a mil. This precision is necessary to avoid problems with gain variation during later operation.

It was decided to defer further expenditures on counter design until a final configuration was established.

### LABORATORY MEASUREMENTS OF FLUORESCENT RADIATION

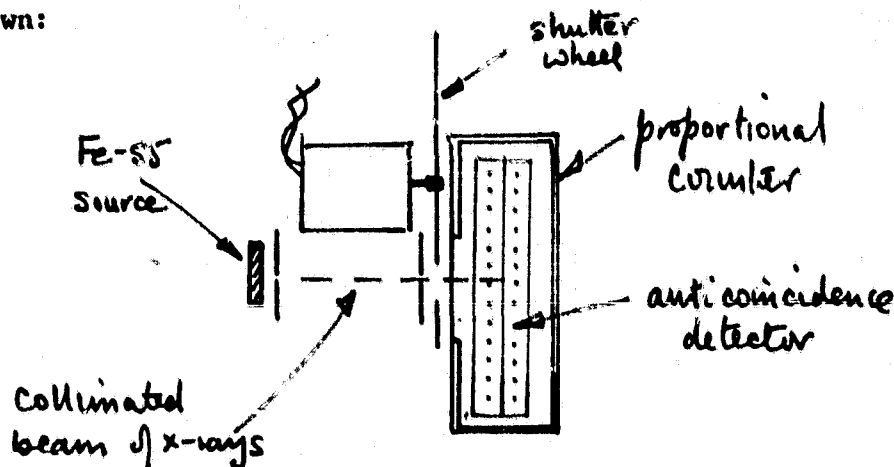
Consultation and assistance was provided to SSL personnel in the setting up and operation of two multiwire proportional counters. These were (a) a 5 mm anode-spacing counter manufactured at the UAM and (b) a 2 mm spacing counter from Columbia University. Since these thin window detectors would be used at reduced pressures it was necessary to operate them inside a vacuum bell-jar. Thus all signals, supply voltages for anodes, preamps, shutter motor, etc., had to be connected via feedthroughs in the vacuum system.

An objective of the SSL group was to measure xenon fluorescence yields. Fe-55 with its Mn K $\alpha$  radiation (5.9 keV) is a useful excitation source for a group of Xe L-x-rays. These have energies in the range

4 to 4.5 keV and should be easy to detect efficiently. However due to the attendant difficulties and expense of using xenon, it was decided to use argon-based counter gases for the preliminary work in assembling a working experimental system. An example of an experiment undertaken with this set-up was as follows:

#### Measurement of the Ar-K $\alpha$ Fluorescence Yield

A beam of Fe-55 x-rays was incident upon a proportional counter cell as shown:



Counting rates in cells 1, 2 and 3 were measured as were coincidence rates for 1:2 and 1:3. The fluorescence yield may be estimated from the relation

$$C - C_{bg} - C_{acc} = N_p \cdot f_g \cdot y \cdot a$$

where:  $C$  = measured coincidence rate between 2 cells with source

$C_{bg}$  = measured coincidence rate without source

$C_{acc}$  = calculated accidental coincidence rate (including correction for accidental anticoincidences)

$N_p$  = measured primary photoelectric interaction rate

$f_g$  = calculated geometric factor for the 2 cells in use

$y$  = fluorescence yield

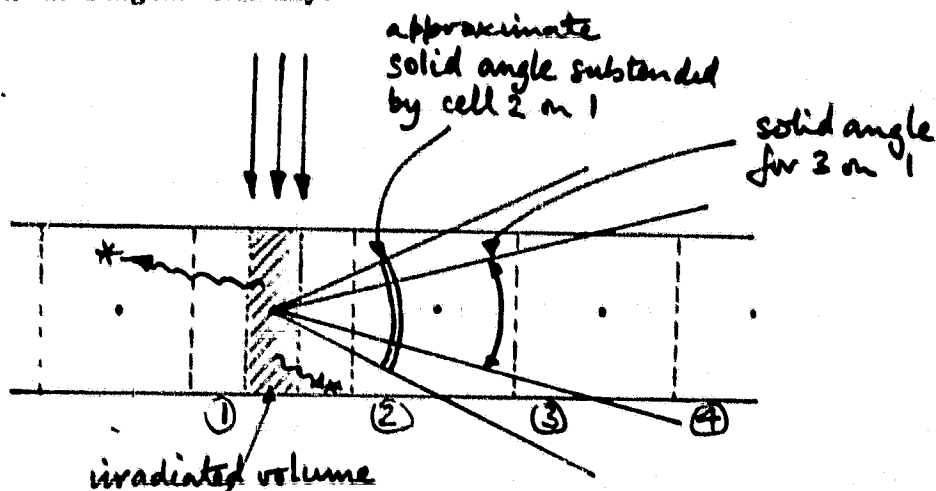
$a$  = calculated absorption probability for a fluorescence photon in the second cell.

The results were:

For adjacent cells (1:2) the product  $f_g \cdot y = 0.011$ .

For 2 cells separated by another (1:3) the product  $f_g \cdot y = 0.007$ .

For these two cases one may estimate the ratios of the geometric factors,  $f_g$ , as shown diagrammatically.



One would expect, very roughly, the ratio  $\frac{(f_g)_{1:2} \cdot y}{(f_g)_{1:3} \cdot y} = \frac{2}{1}$

Using an estimate of  $1/12$  for  $(f_g)_{1:3}$  we obtain  $y = 0.084$ ; which agrees reasonably well with a literature value of 11%. Attempts to measure the Ar L fluorescence yield were frustrated (within the time available) by the physics of the process and the performance and resolution of the experimental system.

#### DESIGN AND CONSTRUCTION OF A GAS-FILLED SYSTEM

Design and specification of a high-purity gas filling system capable of supplying mixtures of xenon and other gases to proportional counters was performed. Consultation and advice was provided to the technicians assembling the system at SSL. The system is complete and currently

operational in that laboratory.

It incorporates the following features:

- low outgassing materials throughout
- provision for 3 gas inputs on the manifold pressure
- gauge of accuracy ~ 1 torr in the range 0-1000 torr
- provision for addition of high vacuum gauge
- low volume dosing system necessary for accurate mixing
- provision for large diameter bypass for pump-down of counter
- gas purifier capable of reducing  $O_2$  and  $H_2O$  in rare gases to 0.1 ppm (specifications supplied)
- high capacity air-cooled turbomolecular pump (with its advantages of cleanliness and great convenience of operation (specifications supplied)).

The system is mounted on a cart and is flexible enough to be easily used as a pumping station for other clean applications.

#### ELECTRONIC ENGINEERING SUPPORT

Assistance was rendered as needed to put into operation various computer-related pieces of equipment. Included were work on the interface between a Data General machine and an I/O terminal and that between a Versatec printer and a PHA analyser.